TRU-Contaminated, Classified Material: Preliminary Assessment of Disposition Options

The Problem

The Department of Energy (DOE) currently has inventories of radioactively contaminated classified weapons parts (non-special nuclear material), molds, and tooling that were generated as a result of nuclear weapon research and development, production, and disassembly activities. Some estimates[1] place the number of shells and molds at over 100,000 pieces, exclusive of the contaminated tooling and gages that are also classified by virtue of shape. This inventory is stored at several DOE sites across the complex, including the Rocky Flats Environmental Technology Site (RFETS), which is slated for protected area closure in December 2002. The level of contamination on these items ranges from low level (≤ 100 nCi/g-bulk) to transuranic (TRU) level (> 100 nCi/g-bulk). Furthermore, this inventory is not static. Activities associated with the proposed Pit Disassembly and Conversion Facility (PDCF), pit manufacturing, and surveillance operations will result in the generation of additional contaminated, classified material. The purpose of this report is to identify an optimal disposition path for the classified TRU material.

The Issues

Classification: Perhaps the most important issue related to this material is that it is classified by virtue of shape, dimensions, weight, and/or composition. As such, the Atomic Energy Act of 1954, as amended, requires that the information embodied by these parts and tools be protected from unauthorized access. This means that the material cannot simply be declared "waste" and discarded. It must be stored with appropriate security protections pending final disposition through an approved process (DOE M 471.2-1B)[2].

Sanitization: DOE guidance[3] for Defense Programs (DP) sites states that "nuclear weapon hardware that is excess to DOE needs shall be stripped of all characteristics that cause it to be proliferation-sensitive prior to disposal." The applicability of this guidance to non-DP sites, such as sites and facilities operated by the Offices of Environmental Management (EM) or Fissile Materials Disposition (MD) is unclear.

Applicability of Environmental Regulations: Prior to sanitization, contaminated classified material is not generally RCRA regulated.

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[1] Dworzak, Wolfgang, and Michael Blau, 1998. ***Contaminated Non-Nuclear Classified Components in the DOE Complex*** (U), LA-CP-98-220, Los Alamos National Laboratory, October (report classified).

[2] DOE, 1999. ***Classified Matter Protection and Control Manual*****,** January.

[3] DOE, 1998. ***Guidance on Demilitarization and Sanitization for Disposition of Nuclear Weapon Components and Related Material***, June.

Demilitarization: If DOE does not sanitize classified parts, the applicability of any demilitarization requirements need to be determined.

Inconsistencies: If the process of *storage with physical protection*, *sanitization*, *demilitarization*, and then *approved disposal* had been followed consistently over the years, there would be no problem related to the material in question. However, because this material has been handled differently under different circumstances, confusion has resulted. First, the material is segregated by time period. The 1970 Atomic Energy Commission (AEC) Immediate Action Directive[4] (IAD) states that contaminated material, in particular TRU-contaminated material, is to be placed in retrievable storage beginning April 30, 1970. Prior to this date, material already buried is considered "disposed of" unless it is retrieved for some reason (e.g., as part of environmental restoration)[5]. Sites operating prior to 1970 routinely buried contaminated classified material—material that per the 1970 IAD is considered to be permanently disposed of provided it was buried before April 30, 1970. It is noted that the 1970 IAD and AEC Manual 0511 are written in terms of "waste." The definition of "radioactive waste" included in AEC Manual 0511 can be read to include the material under consideration in this study. Thus, the 1970 IAD effectively divides this material into pre-1970 material that is considered "disposed" and post-1970 material that is considered in "storage."

In addition to segregation by time period, DOE handles the material in question differently depending on contamination level. If the classified material's contamination is low-level, it is sent to NTS for long-term management. There is no intent[6] to retrieve the material once it is buried at NTS. By virtue of its burial at NTS without sanitization, it can be argued that DOE has effectively declared this material "classified waste"—a combination of terms considered to be inconsistent by DOE/AL chief counsel's office. If the identical material is TRU contaminated, it is generally handled as classified material pending sanitization, not "waste." Even here, however, there are exceptions. For example, at RFETS the custody of a significant amount of classified material no longer required for production needs was transferred from DP to EM. The language of the transfer has been interpreted by the RFETS contractor as a declaration of the material as "waste."[7]

The discussion presented above is not meant to be an exhaustive list of inconsistencies regarding the handling of this material. The intent is to point out that DOE needs to carefully examine how it handles TRU-contaminated, classified material—consistent guidance and a disposition path should be articulated on a complex-wide basis.

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[4] The 1970 Immediate Action Directive was published in advance of its incorporation into AEC Manual 0511 (1973).

[5] See DOE G 435.1-1 for this interpretation.

[6] Note that the material could be retrieved if necessary. It is simply not the *intent* of DOE to do so in the foreseeable future.

[7] "Plan to Disposition Wastes Having Classified Shapes at the Waste Isolation Pilot Plant (WIPP)—LAM-158-00," memo from L.A. Martinez (Kaiser-Hill Company) to Paul Golan (DOE, RFFO), dated April 5, 2000.

Working Group

A working group[8] was formed in October 1999 to address some of the issues introduced above. Given the magnitude of the overall problem, the working group decided to focus attention on a small subset of the material in question. Specifically, it was decided to assess disposition paths for post-1970, TRU-contaminated, classified weapons parts (non-special nuclear materials), molds, and tooling that were generated as a result of nuclear weapon research and development, production, and disassembly activities. This material is maintained in retrievable storage around DOE (Table 1) and currently does not have a defined disposition path. It is emphasized that although the working group is focusing on the material in Table 1, many of the issues and approaches discussed may apply to the pre-1970 material, as well as to the buried low-level contaminated material.

Table 1. Inventory of Post-1970, TRU-Contaminated Material

Site/Facility	Quantity	Material	Comments
Hanford	1312, 55-gallon drums	Shells, graphite molds	Rocky Flats generated material. No plans to begin retrieval before 2007.
SRS	Approximately 45, 55-gallon drums	Parts,	Will be dispositioned under a special campaign in the planned TRU waste-sorting/packaging facility
NTS	248, 55-gallon drums	Tooling, molds, shells	360 additional drums of material are in trenches and in Greater Confinement Disposal (GCD). There are no plans to retrieve any of these 360 drums.
RFETS	Approximately 300, 55-gallon drums	Tooling, molds, shells	247 TRU drums are currently in storage; some future generation is anticipated. Material needs to be removed off-site by September 2004.
LANL	500 – 1000, 55-gallon drums	Shells, tooling, molds	Numbers are uncertain because complete records were not kept before 1988. This may include some pre-1970 material that is being retrieved.
LLNL	16, 55-gallon drums	Shells, parts	
PDCF	Classified	Shells, parts	Baseline facility design calls for a sanitization capability.

[8] "Establishment of DOE Working Group on TRU Contaminated Non-SNM Classified Shells and Certain Pit Components," memo from A.E. Whiteman to distribution, dated October 13, 1999.

Methodology

The methodology applied in this study is based on the identification of differentiating cost and programmatic risk factors among options. Both quantitative and qualitative assessments of available data are used to provide relative ranking factors. This study is considered a first-order assessment of options. If more detailed cost and schedule information were available, a more comprehensive systems study would result.

Cost: Since detailed cost data are not available from all of the sites, cost numbers presented in this study should be viewed as rough order-of-magnitude estimates. These estimates are used to gain some insight into the relative costs among options, but by no means are they representative of the total cost that would be incurred by pursuing a specific scenario. Figure 1 shows the breakdown of life-cycle cost used as the starting point in evaluating relative cost factors. Specific cost numbers used in this study come from working group site representatives, as well as from previously published studies on related topics.

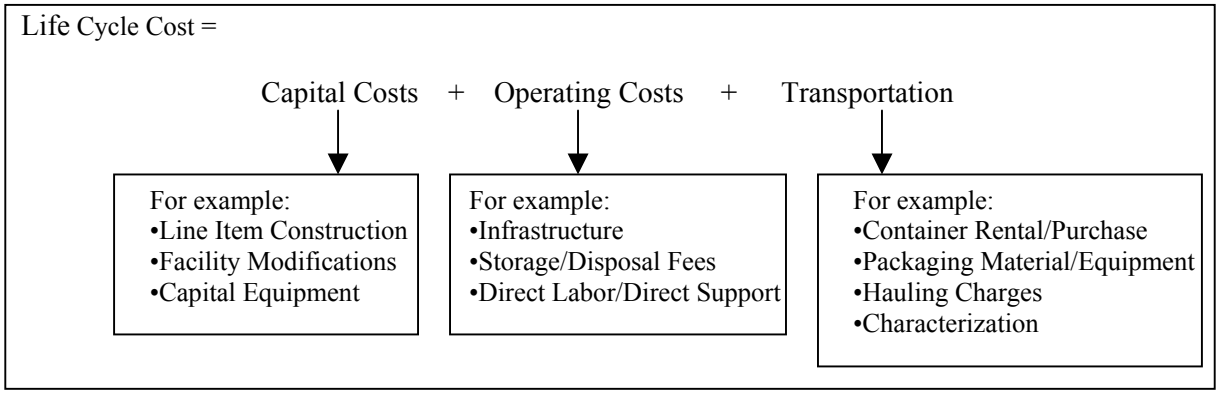

Figure 1. Breakdown of Life-Cycle Costs

Programmatic Risk: In addition to cost, each option carries with it a level of programmatic risk. The specific subcategories of programmatic risk that are considered in this study are:

- **Legal**—legal liabilities associated with a given scenario and their potential effects on DOE
- **Stakeholder**—issues internal to (between program offices) or external to (government, citizen groups) DOE
- **Safety**—safety implications for a given scenario (radiation exposure, complexity of operations)
- **Technical**—technical issues associated with an option (reliance on an unproven technology, delay in deployment)

- **Safeguards/Security**—security issues related to the protection of the classified material

Evaluation of programmatic risk is subjective, and by the very nature of some of the topics (e.g., legal) difficult to predict. As with cost estimates, programmatic risk assignments are made to obtain relative rankings among options.

Assumptions

A number of assumptions go into this analysis. Many of these assumptions are discussed within each scenario description. However, some of the assumptions are pervasive, including:

- Classified material must be removed from Rocky Flats by September 30, 2004. Closure of the protected area in December 2002 will preclude further processing of contaminated classified material and will result in further restrictions on site storage capabilities.
- Hanford will not begin retrieval of their inventory before 2007.
- PDCF will complete Title I design by the end of FY00. (check date)
- Furnaces being developed by LLNL and LANL are capable of sanitizing shells and tooling.
- Sanitization of graphite molds would be accomplished by crushing.
- The maximum classification level of any of this material is *Secret Restricted Data*[9].
- For the purposes of packaging and transportation, the material listed in Table 1 contains a Type B quantity of radioactive material per 49 CFR 173.

Building Blocks

The working group has identified a number of broad options for the disposition of the TRU-contaminated material under consideration:

- Direct Disposal at the Waste Isolation Pilot Plant (WIPP)
- Continued Storage
- Sanitization
- Decontamination

The development of specific scenarios from these generic options is accomplished through various combinations of the following 5 sub-activities (or *blocks*):

- Block 1: Transportation of contaminated materials to WIPP for disposal
- Block 2: Transportation of contaminated materials (not to WIPP)
- Block 3: Construction/operation of a sanitization facility

[9] If the security requirements for this material are increased, this entire analysis will need to be revisited.

- Block 4: Construction/operation of a decontamination facility
- Block 5: Storage of material pending disposition

Block 1: Transportation to WIPP: When materials are transported to WIPP for disposal, they must be packaged in a TRUPACT-II container. Sites must have an approved process for certifying the waste for shipment to WIPP and either rent or buy special equipment for the loading of a TRUPACT-II. The cost components of interest for this block are (1) the cost of establishing a certified program, (2) equipment rental costs, (3) per drum characterization and handling costs. Since most sites have material other than that listed in Table 1 that must be shipped to WIPP, the cost of establishing a certified program is seen as a sunk cost by the DOE—a cost that provides no differentiation among options. Equipment rental and characterization costs, however, can be argued to be proportional to the number of drums that will be shipped by a site. Thus, inventories are used as a surrogate to provide differential cost estimates for this block. The current shipping windows for each site to WIPP are shown in Table 2.

Table 2. WIPP Shipment Corridors

Site	WIPP Window
Hanford	June 2000-2035
SRS	2001-2032
RFETS	1999-2007
NTS	2002, 2005, 2009
LANL	Unknown
LLNL	2006
PDCF	2007-2017

Block 2: Transportation (not to WIPP): The only options currently available for the shipment of the material listed in Table 1 (without size reduction or repackaging) are the TRUPACT-II and the Super Tiger (Model 6400) containers[10]. The characterization and pre-shipment sampling requirements for a TRUPACT-II are significantly more involved than those for a Super Tiger since they directly relate to the WIPP waste acceptance criteria. Also, all TRUPACT-II containers are committed to WIPP and would likely be unavailable for a shipment whose destination is not the WIPP facility. Thus, the Super Tiger is considered the most viable option and will be considered the baseline for all transportation that is not to the WIPP facility[11]. Table 3 documents rental information for a Super Tiger as quoted by Nuclear Fuel Services, Inc.[12]

[10] "Summary Meeting Minutes Resulting from April 5, 2000 Meeting of the DOE Working Group on Classified (Non-SNM) Contaminated Weapons Parts and Process Equipment," memo from James Low (DOE/NMSPO) to Distribution dated April 26, 2000.

[11] Note that the Super Tiger's Certificate of Compliance expires in 2003. It is assumed that an extension can and will be obtained.

[12] "NFS Super Tiger Information," memo from Stephen Best (NFS, Inc.) to Saligrama Rao (Bechtel Nevada), dated December 14, 1999.

Table 3. Super Tiger Rental Information

First Month's Rental	$25,000	Includes all procedures, training, initial supervision, and packaging materials
Subsequent Month's Rental	$12,500	Includes NFS home office technical assistance
Contract Hauler	$3,500	Round-trip
Number Available	2	A third Super Tiger is being refurbished
Super Tiger Capacity	16, 55-gallon drums	A Super Tiger can transport material in other forms (see Certificate of Compliance)

For this block, it is assumed that characterization of the material is required. In some instances, administrative or process knowledge may be sufficient. However, to be conservative, a baseline characterization cost of $2000 per drum is assumed. This is consistent with radioassay costs used by Bechtel Nevada in a previous study[13]. Personnel costs for the loading and unloading are difficult to estimate. It is unlikely that personnel would be hired exclusively for this mission; therefore, it is assumed that existing personnel will be used. Thus, only incremental time charges are directly attributed to this effort. Excluding training costs, which should be approximately equal for all sites, it is assumed that a 4-man crew can load or unload a Super Tiger within a 4-hour period. At a loaded wage of $100/hr for the personnel, a total cost of $3200/shipment results (8 total hours per shipment for 4 people). It is recognized that this is a highly simplistic approach to personnel cost estimation; however, it does provide some relative cost data that can help differentiate among scenarios. Finally, it is assumed that two shipments per month are possible[14]. Assuming no specific destination, Table 4 presents estimates of the relative costs associated with shipping each site's inventory.

Shipment campaigns may be longer or shorter depending on the accessibility of the material and the preparation/characterization performed prior to initiating the campaign. However, based on the assumptions made in this analysis, duration only affects rental charges. Rental charges are relatively small; *material characterization* costs dominate the estimates for those sites with significant inventories.

Table 4. Relative Costs for Shipping by Super Tiger

Shipment Origination	Campaign Duration† (months)	Super Tiger Rental and Hauling Charges◆	Material Characterization✪	Loading/ Unloading▲	Total Relative Cost
Hanford	41	$812,000	$2,624,000	$262,400	$3,698,400
SRS	2	$48,000	$10,000	$9,600	$ 67,600
RFETS	10	$204,000	$600,000	$60,800	$864,800
NTS	8	$168,500	$496,000	$51,200	$ 715,700

[13] Bechtel Nevada, ***Transuranic Waste and Materials Disposition Project—Evaluation of Off-Site Processing Options***, January 18, 2000.

[14] In the previous Bechtel Nevada study, a shipment every week was assumed. An additional factor for conservatism is added to this analysis to allow for delays and/or equipment maintenance issues.

LANL	32	$633,000	$2,000,000	$201,600	$2,834,600
LLNL	1	$28,500	$32,000	$3,200	$ 63,700

†Number of drums divided by 16 (capacity of a Super Tiger) divided by 2 shipments/month—the resulting number is then rounded up
✣First month's rental charged at $25,000 and all subsequent months at $12,500. This number is then added to the number of shipments multiplied by $3500/shipment (i.e., the hauling charge).
❍Number of drums in Table 1 multiplied by $2000/drum (note that an arbitrary figure of $10,000 is assumed for the three carbon steel boxes at SRS).
▲Number of shipments multiplied by $3200/shipment

Block 3: Sanitization Facility: It is the understanding of the working group that in order to sanitize metal shells and tooling, melting with stirring is required. Mechanical methods are either not sufficient to sanitize the material or not considered viable (e.g., crushing metal shells does not remove all classified information, shredding would require the final pieces to be smaller than the original thickness, etc.). Thus, in this study, melting with stirring is considered the baseline technology for sanitizing all metal parts. Crushing is assumed to be the preferred method for sanitizing graphite molds. Volume reduction for the material sanitized—and subsequently shipped to WIPP for disposal—is assumed to be between 50 and 75 percent.

Detailed cost estimates for a sanitization facility originally intended for construction in an existing nuclear facility at LANL[15] are used as the cost basis for this block. The proposed LANL facility includes space for furnaces and crushers capable of handling the material of interest. Equipment costs in the LANL report total approximately $2.3M (installed). This estimate does not include the cost of the first two sanitization furnaces or their associated glovebox. An additional $1.5M is added to account for the purchase of and pre-operational activities associated with the first two sanitization furnaces[16]. A total of $3.8M is therefore used as the baseline equipment cost (purchase and installation) for a two-furnace sanitization facility. This estimate does not include costs associated with the modification of existing space or the construction of new space that may be necessary at some sites. Costs associated with developing or modifying authorization basis documents are also not captured.

Based on furnace development work at LLNL, a throughput of ½ drum of material per day per furnace is assumed. If there are 200 operational days per year, the required operational duration for a two-furnace facility to handle each site's inventory is shown in Table 5. Operational costs for a single furnace facility are assumed to total $1M/year.

Table 5. Estimated Duration of Sanitization Operations

Site	Number of Drums	Duration of Sanitization Operations (1 Furnace)
Hanford	1312	6.6 years

[15] LANL, 1999. ***Sanitization Project: Design Criteria Conceptual Design Report***, prepared for Los Alamos National Laboratory by Merrick & Company, January.

[16]Note that furnaces are added in pairs. The total cost of adding a pair of furnaces is assumed to be $1.5M (Two furnace glovebox ~$400k, design ~$250k, two furnaces ~$150k, power supply ~$100k, other glovebox equipment ~$100k, installation, etc. ~$500k).

SRS	~45	45 days
RFETS	300	1.5 years
NTS	248	1.2 years
LANL	500 – 1000	2.5 - 5 years
LLNL	16	16 days
PDCF	Not Available	Duration of PDCF Operations (10 years)

It is recognized that a two-furnace capability is unlikely to be the most cost-effective approach to sanitization. Additional furnace pairs can be added to the LANL design with relatively small increases in initial equipment cost and minor increases in annual operation costs. Firm estimates are not available; however, for this study it is assumed that each additional pair of furnaces cost $1.5M and that operational costs for the facility rise by $100k/year per additional pair of furnaces. Combining this information with the throughput information produces a family of capability and duration curves that can be optimized based on site inventory. Because of the large uncertainty in the cost estimates presented in this block, this optimization is not presented.

Block 4: Decontamination Facility: Costs related to the construction and operation of a decontamination facility are not available. RFETS and Hanford both have decontamination capabilities; however, these capabilities are currently idle. PDCF also plans to have limited decontamination capabilities. The only cost estimates for a decontamination facility come from a scoping study by RFETS[17]. In the RFETS study, a start-up cost (equipment, facility modifications, etc.) of $1.9M is quoted for a new facility capable of taking material from TRU to low-level contamination. The cost for annual operations for a new system is estimated by RFETS as $950k/yr (144 drums per year).

With respect to throughput, the existing RFETS equipment can only decontaminate ~150 shapes per month. The Hanford equipment's throughput has not been studied and would depend on the specific material characteristics. Material characteristics (topography as well as the adhesion of the contaminant) will determine the effectiveness of any process. Many members of the working group feel that decontamination will have too high of a failure rate for it to be considered a viable option. For the purposes of this study, we will adopt the RFETS assumption that 10% of the inventory cannot be decontaminated to low level and will still need to be sanitized using a furnace. In addition to the efficiency issues related to decontamination, it is important to understand that decontamination activities may produce significant quantities of TRU-contaminated by-product waste (possibly liquid). Some of this process waste stream may require stabilization before disposal. In addition, it is believed that the potential for uptake of radioactive material and possibly worker exposure will be higher for decontamination than for sanitization.

Block 5: Storage: Currently, each site with an existing inventory has a storage capability. The purpose of this block is to identify any constraints on the sites related to storage, as

[17] "Summary Meeting Minutes Resulting from April 5, 2000 Meeting of the DOE Working Group on Classified (Non-SNM) Contaminated Weapons Parts and Process Equipment," memo from James Low (DOE/NMSPO) to Distribution dated April 26, 2000.

well as any additional storage capacity they might have. Rocky Flats is the only site with firm restrictions on the continued storage of classified TRU-contaminated material. Specifically, all classified material must be removed by September 30, 2004 to facilitate site closure by 2006. However, the loss of secure storage and processing areas will effectively preclude management of classified material at RFETS after closure of the protected area in 2002. Other than RFETS, none of the other sites has identified specific deadlines or commitments that require the near-term removal of the material listed in Table 1.

To varying degrees, the facilities listed in Table 6 have indicated that they could support an expanded storage mission. All of these sites caveat their potential for additional storage with the need for a defined and funded disposition path for the material in question. Acceptance of material without such a path forward would meet with significant site management and stakeholder resistance.

Table 6. Sites Capable of Accepting Additional Material

Site	Additional Storage Capacity	Comments
Hanford	Unspecified	An expanded storage mission would require upgrades to the Hanford Central Waste Complex and/or the T-Plant Complex. Because of HQ policy and the TRU PEIS ROD, the issue of accepting material from another facility would have to be discussed with the stakeholders.
LANL	Unspecified	LANL could accept additional material if funding were provided for the construction of a proposed storage facility. Also, LANL management is currently opposed to accepting material from another facility.
LLNL	~50, 55-gallon drums	As part of ongoing R&D work on a sanitization furnace, LLNL could accept approximately 50 additional 55-gallon drums of material for the furnace's prove-in process. An expanded storage mission of any significant size or duration would require transportainers to be sited in the LLNL Superblock. Such an expanded mission would require an update to the existing SAR, as well as management approval.
SRS	Unspecified for non-mixed; there is no capacity for mixed waste	DOE/SR is currently opposed to accepting material without a disposition path and additional funding. Stakeholder involvement may also be required before additional material could be accepted.
NTS	10 Sea-land transportainers (~600 additional 55 gallon drums)	DOE/NV is currently opposed to accepting material without a disposition path and additional funding. Stakeholder involvement may also be required before additional material could be accepted. No significant increases in security or existing storage costs are identified for the additional material.

Scenarios

Under the generic options for disposition, the working group has identified the following scenarios:

- Direct disposal at WIPP
- Continued storage
  - (a) At current storage sites
  - (b) Consolidated storage at selected sites or at a new site
- Sanitization (with disposal of resulting waste at WIPP)
  - (a) Sanitization at two or more storage sites
  - (b) Sanitization at a centralized facility
  - (c) Sanitization using a mobile unit
- Decontamination of material to low level and long-term management at NTS (unclassified TRU material generated by process would be disposed of at WIPP)
  - (a) Decontamination at two or more storage sites
  - (b) Decontamination at a centralized facility

Direct Disposal at WIPP:

The intent of this scenario is to save DOE the direct expense of sanitization by disposing of the material "as is" at WIPP. DOE must first determine whether classified material can be declared waste if not sanitized; whether DOE has the authority to dispose of the material without sanitizing it; and the regulatory effect declaring this material waste may have on the rest of the DOE complex. WIPP's authorization may have to be modified to allow the acceptance of contaminated "material." Security upgrades at WIPP would be necessary. In order to assess what upgrades would be required, and what the costs of these upgrades might be, a vulnerability assessment (VA) was held June 21-23, 2000[18]. The specific purpose of the VA was to identify the security and operational changes needed at the WIPP site to accept and safeguard classified TRU-contaminated material from RFETS. Although the VA was performed for the RFETS inventory, it is applicable to the material stored at all sites. Once the WIPP facility is decommissioned, it is believed that its unique characteristics will preclude the need for any active protection of the classified information. It is expected that at least ~$1M will be required for the necessary security upgrades at the WIPP facility. Operational cost increases are pending the completion of the WIPP security plan and are not estimated. The cost for shipping sites to develop capabilities for handling/characterizing classified TRU waste is not included.

[18] "Compliance Assessment Meeting June 20-23, 2000," e-mail from J.R. Galle to distribution received June 14, 2000.

Applicable Building Blocks:

Block 1: Transport to WIPP

Perceived Benefits:

- Direct cost (upgrades at WIPP and shipment costs) of this option appears low.
- Handling of the material is minimized, thereby minimizing worker exposure.
- RFETS would be able to meet their schedule constraints.
- Allowing for direct disposal at WIPP would open an avenue for disposal for all sites.

Potential Risks/Liabilities:

- The potential effects of DOE's declaration of this material as "waste" have not been fully analyzed—possible issues include whether classified material can be declared waste if not sanitized; whether DOE has the authority to dispose of the material without sanitizing it; and the regulatory effect declaring this material waste may have on the rest of the DOE complex.
- Once emplaced at WIPP, this material cannot be retrieved for any reason. This is not currently seen as an issue; however, it is stated here to emphasize the operating position of WIPP management.
- Implementation of safeguards and security measures at WIPP may not support some site schedules.

Continued Storage at Current Sites:

Continued storage in the current configurations (i.e., "doing nothing") is not possible for some sites. Because of site closure, RFETS has no option but to find another storage/disposal site for their material. In addition, all sites are experiencing pressure to identify a disposition path for their material—they do not see indefinite storage as an acceptable course of action. Ultimately, without clear DOE guidance, each site will be forced to make decisions regarding the final disposition of their material, regardless of the effect these decisions may have on the rest of the DOE. As such, continued storage can only be viewed as a temporary solution. Time can be bought by consolidating the storage of this material from closure sites to other DOE facilities. But a final disposition path is required.

Applicable Building Blocks:

Block 5: Storage

Perceived Benefits:

- No additional short-term cost
- Allows time for the development of a consistent complex-wide solution

Potential Risks/Liabilities:

- RFETS cannot continue to store classified material beyond September 30, 2004.
- Without a complex-wide solution for final disposition, decisions regarding this material will be made site-by-site. Such an approach will lead to inconsistent treatment of the issue.

Interim Storage of RFETS Material:

A consolidation of storage could be pursued with benefit to the DOE. The only immediate need is for the RFETS inventory to be moved to another site. This would eliminate the pressure on RFETS management to pursue specific solutions to their immediate problem (e.g., direct disposal at WIPP) without a complex-wide analysis of the potential implications. Hypothetically, many storage options are available, including the consolidation of the entire inventory in Table 1 at one site (existing or new). However, consolidation of the entire DOEDOE inventory has little benefit in the absence of a sanitization or decontamination facility, and will not be discussed further under this scenario.

The transfer of the RFETS material for interim storage appears possible at Hanford, LANL, or NTS. Based on site input to the working group, consolidation at Hanford or LANL would require the expenditure of significant funds to modify existing facilities or to construct new facilities. Interim storage at NTS, however, appears possible with the least cost. Because the existing storage infrastructure at NTS can support approximately 10 additional sea-land trailers, the entire RFETS inventory could be moved to NTS for the cost of transportation (estimated at approximately $1M in Table 4) and the cost of 7 additional sea-land trailers (~$350k).

One factor related to any interim storage scenario must be emphasized—no site wishes to accept another's material without a clearly defined and funded disposition path. Even with a path identified, it is still likely that any facility that accepts material from another site will have to convince stakeholders that such an action will provide some benefit to them (e.g., the acceptance of material is the first step in getting *all* of the material into a final disposition path).

Applicable Building Blocks:

Block 2: Transport (not to WIPP)	**Block 5:** Storage

Perceived Benefits:

- Transfer of the RFETS material to another site supports the RFETS closure date.
- Allows time for the development of a consistent complex-wide solution to the problem

Potential Risks/Liabilities:

- Sites (and their stakeholders) are not willing to accept another site's inventory without an articulated and funded disposition path for all of the material.
- Interim storage is only a temporary solution—it does not provide for the final disposition of the material.

Sanitization at Multiple Sites:

Given closure schedules and the disproportionate inventories among the sites, the creation of a sanitization capability at every site makes little sense. The RFETS closure schedule precludes location of a sanitization facility at RFETS; therefore, some level of consolidation will be necessary. Both LANL and LLNL will shortly have capability to sanitize items that they have generated. The current baseline for PDCF includes sanitization capability for shells and parts they generate. Balancing non-WIPP shipping costs with sanitization facility costs becomes the primary cost driver for determining where, what size, and how many sanitization facilities should be constructed. From available information, the most obvious locations for adding sanitization capabilities under a multi-site sanitization scenario are Hanford, LANL, NTS, and PDCF. The programmatic issues related to LLNL accepting items from other sites appear, at least at the current level of understanding, to be more involved and expensive to address than those for the four sites listed. A consolidated storage and sanitization facility located at WIPP was not considered as part of this assessment. Some general conclusions and observations include:

- The material at Hanford represents approximately a third of the current inventory. Hanford does not currently have an operational capability to sanitize their material. Shipment costs (Table 4) to consolidate the storage of this material at another site are less than what is estimated to create a sanitization capability.
- NTS does not currently have an operational capability to sanitize their material. Shipping costs to send the material to another site will be significantly less than developing the capability at NTS.
- Both LANL and LLNL will shortly have capability to sanitize items that they have generated. Acceptance of materials from other sites would have to overcome programmatic and stakeholder issues.
- SRS currently has no capability to sanitize their existing inventory. The current baseline for PDCF has a sanitization capability for material generated as part of pit conversion. There is a facility planned in the outyears (2015) to sanitize existing legacy inventory.

- It is assumed that part of this scenario is the disposal of the resulting sanitized/demilitarized waste at WIPP. The sanitized material will likely have a volume between ½ and ¼ the original volume. A corresponding reduction in the number of WIPP shipments will therefore be realized. This reduction in shipments may be insignificant in light of the total TRU inventories of many sites; however, it does represent a theoretical cost savings.

Applicable Building Blocks:

Block 1: Transport to WIPP	**Block 2:** Transport (not to WIPP)	**Block 3:** Sanitization Facility	**Block 5:** Storage

Perceived Benefits:

- The placement of a sanitization facility at Hanford would save significant shipping costs to another sanitization facility. Also, should Hanford retrieve pre-1970 material, the existence of a sanitization facility would streamline disposition of this material.
- A sanitization facility at NTS could also be used for sanitization of low-level classified material .
- Sanitization at SRS would build a solution into a new facility and allow the site to process current and future inventories without relying on another site.
- The sanitization of this material will allow for its definitive classification as "waste" and facilitate disposal at WIPP.
- Multiple facilities would allow greater flexibility within the DOEto deal with classified material requiring sanitization.
- The volume reduction associated with sanitization will result in a reduction in the number of shipments to WIPP.
- No security upgrades would be required at WIPP.

Potential Risks/Liabilities:

- Sites (and their stakeholders) would have to be convinced to accept a sanitization/demilitarization mission.
- Sanitization requires sorting and handling that increases worker exposure.
- The cost of building and running multiple facilities is anticipated to be a higher cost option.

Sanitization at One Site:

If a single sanitization facility is constructed for the DOE, it will need more than one furnace. To sanitize the existing inventory[19] with one pair of furnaces would require approximately 15 years. Using the assumptions in Block 3, the current inventory (excluding the PDCF generation) would be best sanitized by a 6-

[19] Existing inventory excludes PDCF projections.

furnace facility operating for approximately 5 to 6 years. The effect of adding the PDCF inventory is unknown, but for this study it is assumed that an additional 2 years of operations would be required. As for the multi-site scenarios, the available cost data are insufficient to make any firm conclusions.

Applicable Building Blocks:

Block 1: Transport to WIPP	**Block 2:** Transport (not to WIPP)	**Block 3:** Sanitization Facility	**Block 5:** Storage

Perceived Benefits:

- The placement of a sanitization facility at Hanford would save significant shipping costs to another sanitization facility. Also, should Hanford retrieve pre-1970 material, the existence of a sanitization facility would streamline disposition of this material.
- A sanitization facility at NTS could also be used for sanitization of low-level classified material Expanded sanitization capability at LANL or LLNL would be required to process complex-wide legacy material, as well as their annual generation.
- Sanitization at SRS would build a solution into a new facility and allow the site to process current and future inventories without relying on another site.
- The sanitization of this material will allow for its definitive classification as "waste" and facilitate disposal at WIPP.
- The volume reduction associated with sanitization will result in a reduction in the number of shipments to WIPP.
- No security upgrades would be required at WIPP.
- Intuitively, this should be a lower cost option.
- Start-up costs (e.g., permitting, authorization basis, etc.) would be lower for one facility than for multiple facilities.

Potential Risks/Liabilities:

- Sites (and their stakeholders) would have to be convinced to accept a sanitization mission.
- Sanitization requires sorting and handling that increases worker exposure.
- The cost of building and running a facility is non-trivial.

Sanitization Using a Mobile Facility

One other option for sanitization remains—that of a mobile sanitization facility. The development of such a facility would eliminate non-WIPP shipment costs (with the exception of the RFETS inventory). The idea is based on conceptual designs presented by LANL[20] and is an offshoot of their Mobile Visual

[20] "Summary Meeting Minutes Resulting from April 5, 2000 Meeting of the DOE Working Group on Classified (Non-SNM) Contaminated Weapons Parts and Process Equipment," memo from James Low (DOE/NMSPO) to Distribution dated April 26, 2000.

Examination and Repack system. Conceptually, the Mobile Integrated Demilitarization and Sanitization (MIDAS) system would be composed of a set of trailers that allow for the sorting, melting (2 furnaces), and/or crushing of TRU-contaminated classified material. The trailers themselves are certified for shipment of Type A quantities of nuclear materials. No cost data are available for the MIDAS system, but it is believed that significant developmental work would be required before such a system could be fielded.

Applicable Building Blocks:

Block 1: Transport to WIPP	**Block 5:** Storage

Perceived Benefits:

- A mobile sanitization unit would allow the DOE to save Block 2 shipment costs (with the exception of RFETS material).
- The sanitization of this material will allow for its definitive classification as "waste" and disposal at WIPP.
- The volume reduction associated with sanitization will result in a reduction of the number of shipments to WIPP.
- No security upgrades would be required at WIPP.

Potential Risks/Liabilities:

- The integrated concept (sorting, melting, packaging) has not been demonstrated and may require significant investments of time and money to field.
- Significant effort (e.g., authorization basis) would be required for each site to allow operation of this equipment at its site.
- Sanitization requires sorting and handling that increases worker exposure.
- The trailers are rated for the transport of Type A quantities of nuclear material. Once used, some equipment of the MIDAS unit would have to be decontaminated to a Type A quantity (53 mg weapons-grade plutonium) or be replaced before the unit could be moved.
- A single MIDAS unit may not be sufficient for the overall task, or cost-effective to maintain. A two-furnace capacity would require 8 years to sanitize the existing inventory, followed by several more operational years to handle the PDCF production.

Decontamination to Low Level:

As with the sanitization options, multiple scenarios can be developed related to decontamination (e.g., it could be done at one site or multiple sites). However, because of the reasons discussed below, these variations on the overall scenario

were not pursued for this study. First, as presented in Block 4, the costs of setting up and operating a decontamination facility are not significantly different from those of a sanitization facility (at least at the current fidelity of cost information). Also, there is a good chance that decontamination will not be successful on all of the material. The RFETS estimate referenced in Block 4 assumes a 10% failure rate. At this rate, there would still be several hundred drums of TRU-contaminated material that remains classified by shape. Thus, some form of sanitization facility would still be required. In addition, the throughput of a decontamination facility is estimated to be less than that of a sanitization facility. Thus, the operational lifetime and corresponding cost will likely be higher. Decontamination also produces a by-product waste stream requiring disposal at WIPP. Finally, decontamination is seen as a more "hands on" process than sanitization; thereby increasing worker exposure and the potential for injury (i.e., puncture wound) and contamination.

Applicable Building Blocks:

Block 1: Transport to WIPP	**Block 2:** Transport (not to WIPP)	**Block 4:** Decontamination Facility	**Block 5:** Storage

Perceived Benefits:

- Decontamination to low level would open up an approved disposition path for the material (i.e., NTS long-term management).
- Shipment to and long-term management of low-level material at NTS is significantly less expensive than shipment and disposal at WIPP.
- No security upgrades would be required at WIPP.

Potential Risks/Liabilities:

- Decontamination is not 100% effective. The disposition path for remaining contaminated material would need to be determined.
- Sites (and their stakeholders) would have to be convinced to accept a decontamination mission.
- Decontamination will likely require greater worker exposure than sanitization (e.g., if hands-on scrubbing of parts is required, etc.) and have a higher potential for worker injury and contamination.
- Secondary waste requiring disposal at WIPP is generated.
- Expected to have a low throughput, which increases the life-cycle cost and may not support the closure schedule for RFETS.

Scenario Ranking

Based on the data and discussions presented above, a qualitative ranking of scenarios was performed. For each scenario, a value of 1 (low risk), 2 (medium risk), or 3 (high risk) is

assigned to each of the cost[21] and programmatic risk categories (Table 7). No weighting factors are applied. Therefore, the lower the total, the more attractive the option.

Table 7. Qualitative Ranking of Scenarios

	Direct Disposal at WIPP	Continued Storage❖		Multi-Site Sanitization	Single Site Sanitization	Mobile Sanitization	Decon and shipment to NTS
Cost	1	2		3	2	3★	3✪
Legal	3†	2		1	1	1	2
Stakeholder	1	3		1	3	2	2
Safety	1	2		2	2	2	3▼
Technical	1	1		2♣	2♣	2♣	3
Security	2	1		1	1	1	1
TOTAL	9	11		10	11	11	14

❖This option assumes RFETS material is shipped to another site.
†A high relative risk is assigned here to reflect that a legal analysis and corresponding HQ position regarding the sanitization of classified parts has not been completed.
★The cost of a mobile sanitization facility is unknown; however, the cost is considered high because it would require demonstration of integration.
✪Decontamination is viewed as a costly scenario because of an assumed low throughput, the additional waste streams produced, and the fact that decontamination is not 100% effective.
▼Decontamination is assumed to have more worker handling than sanitization, therefore the risk factor is increased to reflect the potential for puncture wounds and worker contamination.
♣These options will require lead time to obtain capital funding and are therefore rated as a medium risk.

Findings:

- Direct shipping to WIPP appears to be the most advantageous option if the legal issues are resolved.
- Decontamination and long-term management at NTS appears to be the least attractive option.
- Because of site agreements, the continued storage option is not tenable.
- Based on the available data, the sanitization options cannot be differentiated.

Path Forward

As a priority, the outstanding questions regarding the *direct shipping to WIPP* scenario must be answered. A legal analysis should be performed to assess the viability and ramifications of disposing of the material without sanitization. In addition, the security upgrades required for WIPP to accept classified material must be approved and a firm cost estimate obtained. As a contingency to direct shipping to WIPP, an interim storage site and disposition path must be immediately identified for RFETS material. On a parallel path, additional analysis should be conducted to differentiate between the

[21] Because of the lack of complete cost data, relative life-cycle costs are not reported. It is believed that these costs would be misleading, and could bias future efforts. A linear scale should not be assumed for the qualitative ranking of cost risk. A factor of "2" simply represents an option with noticeably higher costs than an option ranked "1".

sanitization alternatives. This will necessitate the development by each site of detailed cost estimates that are currently not funded.

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